

Chinese approaches to sustainable manufacturing

Ö. S. Ganiyusufoglu

Shenyang Machine Tool (Group) Co., Ltd.

Abstract

The balance of global economic power is shifting. Traditionally strong countries are stagnating and a new corps of hopefuls is waiting in the wings. These emerging countries are characterized by largely untapped natural resources and a wealth of latent human talent. At the same time, internet penetration and the revolution in speed of communication has laid the foundation for a new type of Industrial Revolution with sustainable manufacturing at its heart. China is at the forefront of this new group with a number of industries well-positioned to step forward onto the global stage. This paper discusses the current status and strategic plans of Shenyang Machine Tool, the largest machine tool manufacturer in the world. Sustainable manufacturing is only just entering the consciousness of the global machine tool industry. There is not only tremendous capacity for the implementation of sustainable manufacturing principles, the very future of the industry depends on them.

Keywords:

China, Co-operations, Machine Tools, SMART, Sustainable Manufacturing

1 INTRODUCTION

The global economic balance is undergoing dramatic change. The mature, industrialized countries are stagnating; their pace of development slowing. Protecting their competitive positions is becoming harder and harder. Rather than set new standards, individuals are challenged just to maintain the existing ones. Decreasing resources and increasing energy demands are creating higher costs not only for manufacturing goods but also in our daily lives.

Meanwhile, some emerging countries are attracting more and more global attention. Their largely untapped potential for development, both in terms of human capital and natural resources, grants them an important position on the global stage. In particular the BRICS countries, comprising Brazil, China, India, Russia and South Africa, are fast becoming essential players in the global economy.

Regardless of development level, the advent of new technology and the rise of social media have made global communication at incredible speed a reality for all. This will have an important impact on future global development. Already, the current phase has been named Industry 4.0 – as in the 4th Industrial Revolution.

The aforementioned developments combined with the rise of sustainable manufacturing processes will lead to new products in all areas of life as well as to new ideas for manufacturing itself and the business environment

This presentation examines the Chinese approach to sustainable manufacturing via the example of the country's leading machine tool manufacturer. As machine tools are "mother machines" for any product in the world, the aforementioned conditions will have a critical impact on the development of new machine tools. Furthermore, as mother machines their advancement will induce great changes across the world.

2 INTRODUCING SHENYANG MACHINE TOOL

Despite tracing its roots back to the late 1930s, the Chinese machine tool industry was a relatively late entrant to the world stage. Post-reform and opening up, as China's economy gained steam and began to record decades of unparalleled growth, the domestic machine tool industry also underwent tremendous expansion.

Shenyang Machine Tool Group (SYMG) was founded in 1995 through consolidation of the three largest machine tool works in Shenyang, China's historical manufacturing heart and the capital of Liaoning province.

Ranked 36th globally by revenue in 2002, SYMG by 2011 not only stood at the forefront of China's machine tool manufacturers but had become the world's largest machine tool manufacturer with revenues in excess of €1.8 billion.

With aggressively-funded strategic R&D centers in Berlin, Shanghai, and Beijing and a global workforce of 18,000 highly skilled workers, SYMG is uniquely positioned to capitalize on the coming industrial transformation.

3 INDUSTRY DEVELOPMENT MILESTONES

With equipment operation an entirely manual affair, in its infancy machining revolved around the development and maintenance of a highly skilled workforce. Apprenticeships were common and peak worker productivity was only realized after years of gradual training and study.

The first big breakthrough was the advent of 'numerical control' (NC) in the early 1940s. Existing manual machining equipment was retrofit with crude motor-driven mechanical assemblies that accepted punched tape to control workpiece location, cutting speed and depth. In a stroke, one expert machinist could record his sequence of actions and

propagate them via punch tape across entire factories. The impact on production efficiency was staggering.

As the 1960s wore on and the computer revolution took hold the next great breakthrough was the arrival of 'computerized numerical control' (CNC). A natural successor to NC systems, CNC was the end of the traditional machinist as the industry had known him for decades. In his place now stood a highly skilled designer who programmed the machines and a team of relatively lower skilled operators which oversaw the loading, activation, and unloading of individual machine tools. This arrangement led to another leap forwards in productivity and also dramatically increased the flexibility, as machining programs could be easily and quickly modified as needs required.

From the 1980s onward the manufacturing industry continued to experience technical breakthroughs: cutting speeds rapidly increased, automation and robotics went from high concept to baseline technology, and hybrid CNC platforms capable of performing a variety of cuttings tasks including turning, milling, tapping, laser cutting and so on rose to prominence.

Despite this continuous technological progress, the actual productivity, efficiency, and flexibility gains generated at each step of development have been diminishing for some time. Core technologies have standardized across manufacturers, deep research and design spending is yielding fewer and fewer returns, and the pace of development has begun to stagnate.

Current cutting-edge research is concerned with maximizing the efficiency of energy usage and raw materials, and creating more environmentally-friendly products. These motivations, honorable though they be, are meaningful only for the uppermost reaches of the manufacturing industry. Reducing electrical consumption by 2%, for example, is of relatively little consequence to the manufacturing industry's mid- and low-market level customers. They have more pressing needs and, as we shall see, they are legion.

4 TRENDS IN MACHINE TOOL DEMAND

4.1 Global overview

7.2 billion strong today, the world's population is forecasted to reach 8.1 billion in just over a decade and 9.6 billion by 2050 with nearly all of the growth occurring in developing countries.[1][2] Only 1.25 billion people around the world live in developed countries, yet these are the markets that current machine tool research and design efforts almost exclusively target. The amount of potential buyers for high-end machine tools in Africa hardly justifies the cost overhead of setting up a retail outlet!

4.2 Regional highlights

The coming sea-change in economic influence is as predictable as it is unavoidable. Markets which were once afterthoughts, customers both overlooked and ignored, are tomorrow's most sought-after commodity.

The economies which dominated the latter half of the 20th century will be marginalized by the middle of the 21st as Figure 1 from the OECD aptly illustrates.

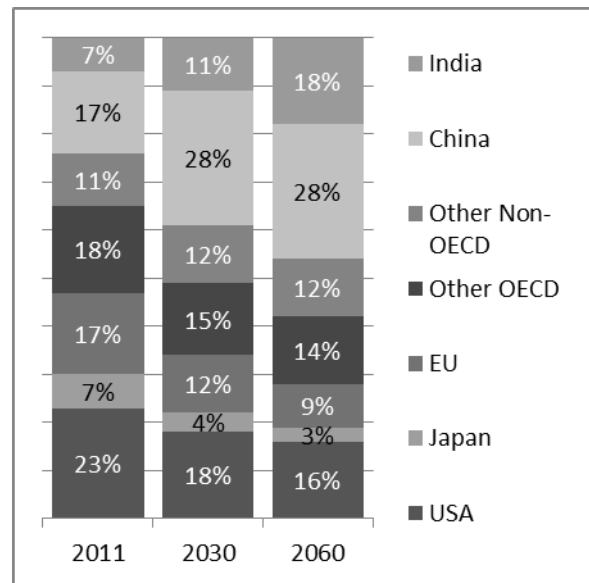


Figure 1: Forecasted % of global GDP.[3]

While this impending economic transition is well-understood, far less time has been spent considering the product demand implications of such a shift. As an example, in 2010 China overtook Japan to become the world's second largest economy but three years later many industries are still grappling with how to design, develop, and market products from the ground up for the Chinese consumer.[4]

The machine tool industry is no exception. Despite clear data regarding on-going demographic and economic shifts, key manufacturers have yet to begin tailoring their products to these new markets.

While manufacturing needs are broadly consistent, it is not so simple as localizing documentation and certifying quality under new legal frameworks. Failure is certain if manufacturers don't respect the characteristics of these new markets. Time must be taken to understand their manifold differences in everything from history and culture, to behavior patterns, communication methods, and work-life balance.

5 THE INTERNET AS GAME-CHANGER

5.1 Who is online?

Three billion people will be online by 2016. It is expected that nearly 4/5ths of all broadband devices will be mobile. In 2005 within the G-20 countries 68% of online users were from developed nations. By 2015 that ratio is expected to flip: 67% of the online community will be in developing countries.[5]

What's more, these developing country user bases are comfortable with a far higher average level of Internet technology than their developed country peers. As economic latecomers, they were non-participants during the early decades. To them there is no 'Web 2.0' because they didn't experience Web 1.0, there is simply the Internet. This makes them comparatively flexible and quicker to embrace new technologies, when they can be afforded.

5.2 The new players

Generation Y is now climbing the corporate ladder. While they have yet to ascend high enough to directly influence purchasing decisions, they dominate the factory operator ranks.

Whereas their predecessors painstakingly adapted to each new increment in computerized manufacturing, Generation Y has grown up with email, mobile phones, and instant messaging. Touch screens are a standard feature, not a frivolous optional accessory. Manual tool controls are unthinkable inefficient.

The manufacturing environment these young, talented individuals are entering is the twilight era of computer integrated manufacturing. Computer-aided drafting, engineering, production, quality, and management – all breakthroughs at one time – are now industry standards. Rather than ask a candidate if they are familiar with CAD, one inquires as to which platforms they've used and with which programming languages they are fluent.

The stage has been set for the next great leap forward.

5.3 Industry 4.0 & Impact on manufacturing

After successive decades of diminishing manufacturing R&D returns on efficiency, productivity, and flexibility a new era of unprecedented potential is almost upon us.

The simultaneous arrival of a technologically adept global workforce, deep penetration of Internet access around the world, and the rise of emerging economies is creating a synergy that will transform the entire manufacturing industry – the era of 'Internet Driven Manufacturing' (IDM) is on the horizon.

Via IDM a design engineer in Bangalore can upload her CAD schematics to a cloud marketplace and production solicit bids from a family-owned shop on the outskirts of Jakarta. Via IDM a factory foreman from Kenya can use his mobile phone to monitor production and issues orders while attending a lecture during a symposium in Johannesburg. Via IDM a service engineer in Berlin can fly overnight to São Paulo and pay a service call to his key customer before they are even aware something is wrong because the machines have automatically notified their manufacturer.

Succeeding in Industry 4.0 will require talented personnel, comprehensive IT infrastructure, economic strength, and enlightened manufacturers.

6 HOW CHINESE MACHINE TOOL MANUFACTURERS ARE ADAPTING

As the world's shop floor, and with the largest Internet community on Earth, China stands ready to make the most of Industry 4.0.

6.1 Strategic innovation

Long noted for their ability to imitate and adapt the designs of others, the Chinese manufacturers are beginning to blaze their own path. With nearly 50% of all machine tools in the world sold domestically, Chinese manufacturers are virtually right next door to their most important customers. With strong central government support, the industry has moved beyond asking 'what' and is now entering a phase of 'strategic hows':

- How can we help our customers reach their own goals?
- How can we minimize capital risk and thereby lower the bar to market entry?
- How can we generate new revenue from products already in the field?
- How can we capitalize on the technical savvy of our customers?
- How do we differentiate ourselves in an era of technological homogenization?

The corporations which can answer these questions are tomorrow's industry titans.

6.2 'Co-Operations'

Those that do attempt to answer the questions above are beginning to understand that within the manufacturing industry no one entity is in position to provide all the know-how, services, and equipment that the 21st century customer needs. Furthermore, there isn't time to develop the missing capabilities. The market cannot wait.

The solution as we are now seeing today is the rise of 'Co-Operations' within the manufacturing industry. Companies are moving beyond the traditional vendor-client relationship to create harmonious partnerships. Rather than providing the customer a list of 'manufacturer approved' third-party accessories providers, companies are now approaching the customer as a team with a portfolio of complimentary products and services.

6.3 Embracing global cooperation

To their credit, the Chinese manufacturers are not just reaching across corporate lines, they are crossing borders as well. The machine tool industry has technological and industrial hubs in North America, Europe, and East Asia. Chinese manufacturers are actively seeking out international partners with complimentary capabilities to create highly effective, well-rounded alliances. What was once a corporate climate of defiant independence is giving way to the realization that ably standing on equal footing with other industrial champions has yet more merit.

7 NEXT GENERATION MACHINING

7.1 Development trends

Machine tool manufacturers are turning away from chasing ever smaller fractional gains in cutting speed and accuracy, and are instead attacking other aspects of the complicated modern machining process. The following areas are where future growth potential is found.

7.2 'SMART' products

First and foremost, 'SMART' machine tools are *simple*. That is not to say they lack features or capability. On the contrary, the next generation of machine tools are more feature-rich and flexible than any before. Rather, careful attention is paid to make the user experience as logical, comfortable, and effortless as possible. In this way new operators can quickly make strong contributions to production.

Secondly, 'SMART' machine tools are *maintenance-friendly*. In this industry downtime as an event is unavoidable, but its nature and duration can be controlled through intelligent design.

Thirdly, 'SMART' machine tools are *affordable*. Global economic growth for at least the next three decades will be concentrated in markets for whom the machine tool high-end segment is wholly out of reach.

Fourth, 'SMART' machine tools are *reliable*. While the technological gap between low- and high-end machine tools has narrowed considerably, reliability differences remain. Next generation machine tools will allow mid- and low-level customers to operate round-the-clock worry-free.

Lastly, 'SMART' machine tools are *timely* to market and profit. In other words they must be quick to build, customize, deliver, and succeed. This will be accomplished via the widespread adoption of modular design principles which have already been put to great use in other industries and by actively engaging the customer at all steps of the business process.

7.3 'SMART' enterprises

Creating these new **smart** products will be **smart** enterprises. Multidisciplinary, multicultural, and egalitarian, these corporations will present their customers with efficient, flexible, customized interactions at all stages of the business process.

While long-term strategy will still be set by a core group of visionaries, frontline employees will be empowered with the authority necessary to resolve any and all customer issues.

The corporation will be able to marshal expansive resources to meet market needs while still presenting a personal link to individual customers.

7.4 New business model

An industry once characterized by a 'sell and forget' mentality is speeding towards an integrated solutions provider business model with sustainable manufacturing at its core.

Well-built machine tools have a life-expectancy measured in decades, but the needs of individual customers develop on the order of years. Establishing comprehensive upgrade, refurbishment, and buyback operations allows for still-useful equipment to find its way into the hands of grateful new owners while freeing the original customer to invest in greater hardware.

The 2008 financial crisis and ensuing collapse of lender credit had a devastating impact on the manufacturing industry. Operating on already tight cash flows, when credit lines dried up SMEs found themselves caught in a vicious cycle: unable to purchase new tooling they could not receive new orders, unable to receive new orders they could not generate the cash necessary to purchase new tooling. Credit liquidity has been slow to return. Forward-thinking machine tool manufacturers are filling this void by developing their own internal financing mechanisms. Customers are responding

very positively as they realize their interests of their creditor and business partner are finally aligned, since they are the same entity.

8 CONCLUSION

The machine tool industry's decades-long pursuit of speed and accuracy is fast coming to an end. The rise of the wired populace, optimization of global communications infrastructure, and growing importance of developing economies heralds a new era of machining and a new definition of 'best' product. Ergonomics, reliability, digital integration, and robust product portfolios are the keys to the next generation. China, due to its role as the world's workshop, its tremendous online population, and its economic strength is uniquely positioned to lead the coming revolution of sustainable, smart manufacturing.

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